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PRECONCENTRATION OF SCANDIUM FROM BAUXITE RESIDUE LEACHATES BY SUPPORTED IONIC LIQUID PHASE

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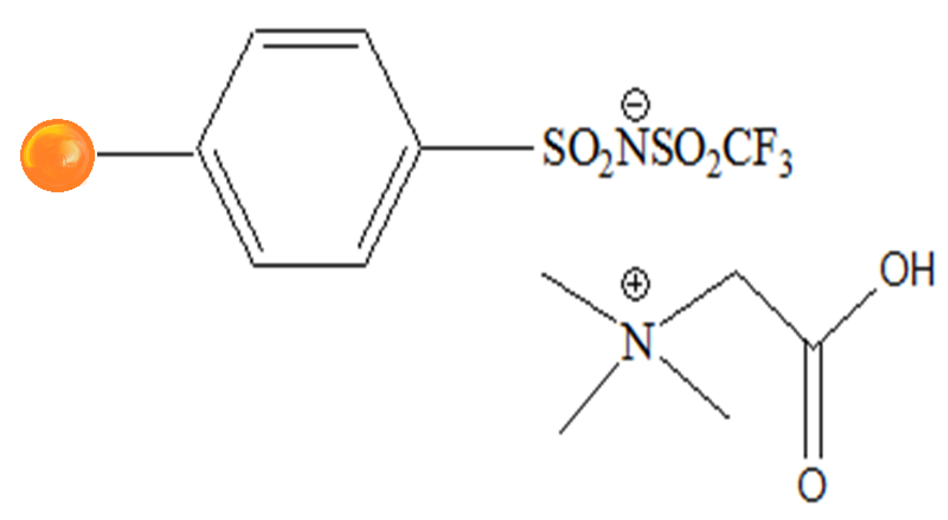
Bauxite residue (BR) or red mud is a by-product in the production of alumina by the Bayer process. About 1–1.5 tonnes is generated for each tonne of alumina produced [1]. Still, BR contains relatively large concentrations of not only elements like aluminium, iron and titanium but also of scandium, yttrium and other rare-earth elements (REEs), which are being used in high-tech applications. Therefore, BR can be considered as a secondary resource of REEs and reduce their supply risk, as their current global production is dominated by China which continues to grow the REEs export quota [2]. Besides, because of a storage problem there are attempts all over the world to valorise BR. Solvent extraction is commonly used to separate REEs or to produce mixed REEs compounds. Ionic liquids (ILs) as solvents exhibit tuneable properties for metal recovery, but still they have a high viscosity which may involve drawbacks in a process design. On the other hand, the IL in supported ionic liquid phases (SILPs) maintain large specific surface area and mechanical properties of the support, thus circumventing mass transport limitations and being suitable for metal preconcentration, taking into a consideration that the concentration of REEs in BR is rather low compared to other major elements.

Aim

- The recovery of scandium with a novel SILP as a potential adsorbent for scandium preconcentration and purification from bauxite residue leach solutions.
- Different parameters for Sc(III) adsorption from chloride media were studied, and here we present several crucial: influence of pH, kinetics, selectivity and reusability of SILP.

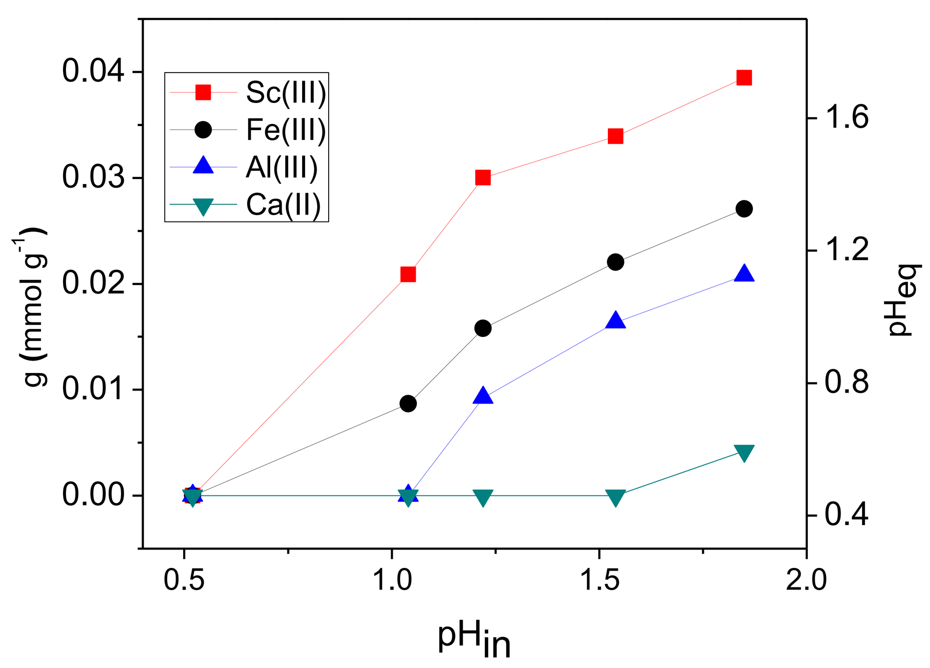
SILP



▲ Chemical structure of SILP

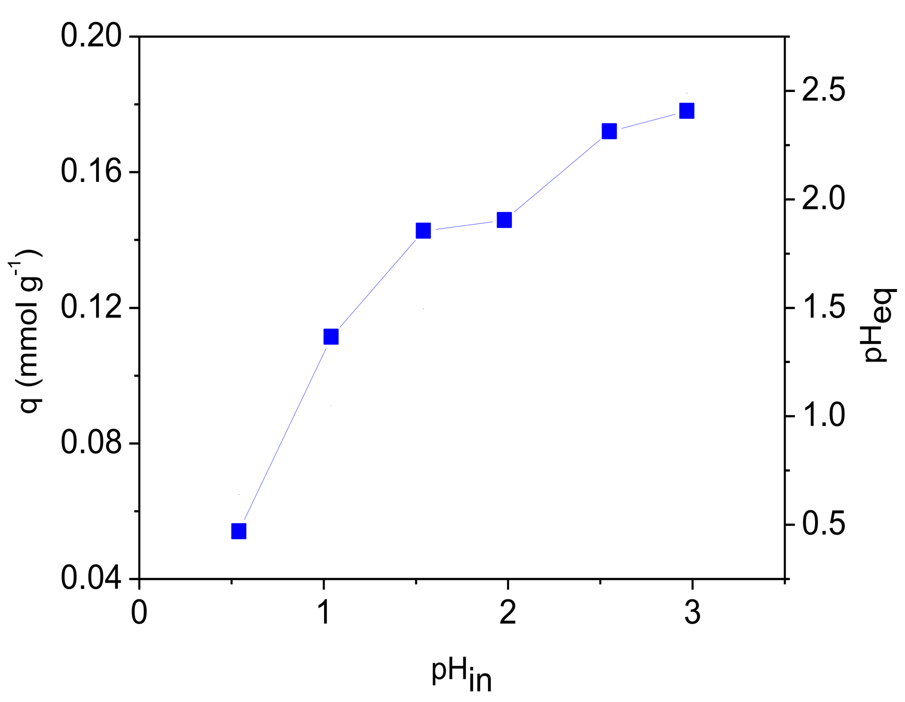
- The SILP was synthesized modifying a poly(styrene-co-divinylbenzene) sluphonyl chloride resin.

Selectivity



▲ Multielement equimolar solution with total concentration of 1.1 mmol L^{-1}, aqueous phase 10 mL, 0.05 g of SILP, 90 min, 300 rpm.

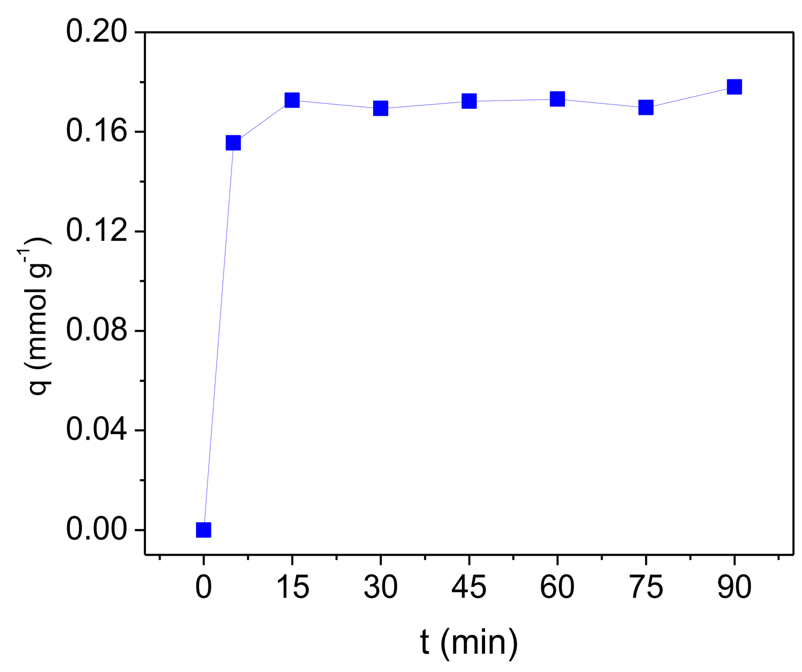
Influence of pH



▲ Aqueous phase 10 mL, 0.05 g of SILP, Sc(III) concentration 1.1 mmol L^{-1}, 90 min, 300 rpm.

- Since SILP contains a carboxylic group most likely the adsorption occurs via a proton exchange. Therefore higher pH favours Sc(III) adsorption.

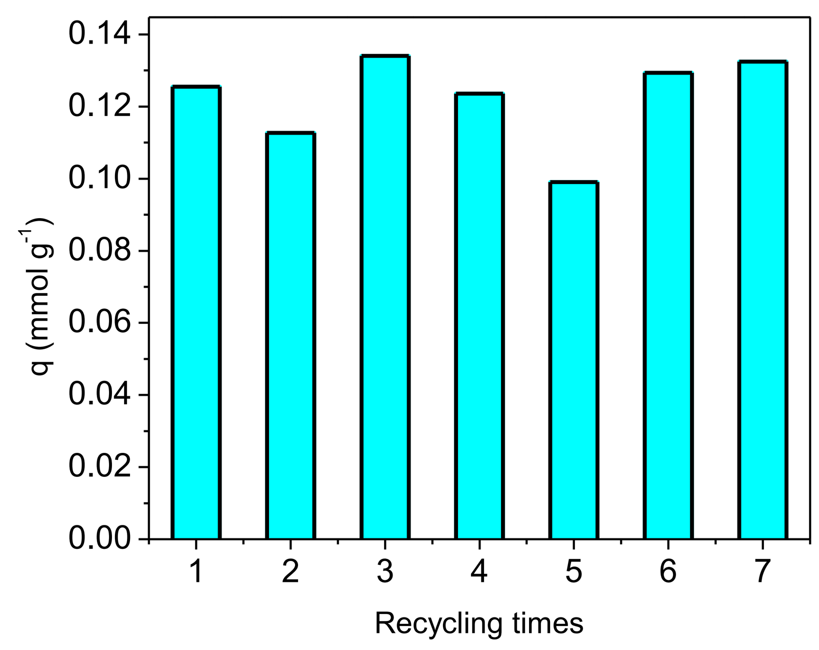
Kinetics



▲ Aqueous phase 10 mL, 0.05 g of SILP, Sc(III) concentration 1.1 mmol L^{-1}, pH_{in}=3.0, pH_{eq}=2.5, 5-90 min, 300 rpm.

- The experimental data were fitted into a pseudo-second order kinetic model (R^2=0.99). From the kinetic studies the theoretical maximum adsorption capacity was 0.18 mmol g^{-1}.

Reusability of SILP



▲ Aqueous phase 10 mL, 0.05 g of SILP, Sc(III) concentration 1.1 mmol L^{-1}, 30 min, pH_{in}=3.0, pH_{eq}=2.5, desorption with 2 mL of 1 mol L^{-1} H_2SO_4, adsorption/desorption time 30 min, 300 rpm.

- Compared with other tested acids (hydrochloric and nitric) quantitative desorption of Sc(III) was achieved with 1 mol L^{-1} sulphuric acid.

Conclusion

- A SILP with poly(styrene-co-divinylbenzene) support and covalently bonded IL with carboxylic functional group was prepared. The SILP exhibited fast kinetics and adsorption capacity high enough for recovery of Sc(III) from acidic bauxite residue leachates. Among other major elements present in the red mud leachates Sc(III) is preferentially adsorbed with SILP. Even after seven batch experiment adsorption/desorption cycles there was no significant difference in adsorption efficiency of SILP.
- With tuneable properties of ILs and advantages when combining with a solid supports, SILPs are a promising adsorbents for recovery of valuable metals.

Acknowledgments

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[1] S. Kumar, R. Kumar, A. Bandopadhyay, *Resour. Conserv. Recycl.*, 2006, 48 (4), 301-314
[2] K. Binnemans, P.T. Jones, B. Blanpain, T.Van Gerven, Y. Pontikes, *J. Clean. Prod.*, 2015, 99, 17-38